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Cost Modeling of Defence Components for Smaller Scale Contingencies

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Abstract

This paper describes the application of a computerized simulation model developed for estimating the costs associated with different defence structures. It is currently under use for cost-effectiveness studies as a part of an ongoing analysis of the future structure of the Norwegian defence. The model is meant for long term planning (15-20 years), and integrates investment costs as well as the cost of operating existing and future material and units. Forces might be simulated separately or in combinations. Examples of output will be presented. Advantages and shortcomings experienced with this type of simulation model are also discussed.

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14. ABSTRACT

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1. Introduction

The purpose of this paper is to describe the cost simulation model KOSTMOD. The tool itself will be described together with an outline of the planning process, and our experience from the application of KOSTMOD with the new focus of planning.

The Norwegian Defence is currently undergoing a major restructuring as a consequence of the new world security environment. The defence planning focus has recently shifted from defence of national territory towards emphasis on a wide spectrum of Smaller Scale Contingencies (SSC) type missions abroad (it can even be argued that in the new security environment, the classic national territory defence in an international context, may now be labelled an SSC). FFI is supporting this restructuring with long term planning and KOSTMOD has a central place in the planning process.

The current long term planning process, Chief of defence 2003 defence study (MFU03), is an in-depth study of the future structure of the defence services. It represents an integrated analysis based on separate surveys of Navy, Army and Air Force as well as the home guard and joint units/divisions. As a result of the MFU03, recommendations to the Chief of Services on the future target structures are made. The tentative future targets structures correspond to different resource levels assumed available to the Norwegian defence.

2. Overarching method

The overall guidance for developing the defence structure is formulated through defence mission or ambitions, structural goals and budget appropriations. The defence mission includes the major defence tasks and how well they should be solved. To ensure a sustainable defence development over time, the overall guidance and the plans should be as consistent with the reality as possible.

MFU03 is developing and describing a number of alternative defence structures with corresponding costs and performances. Insight into the costing over a longer period, e.g. 20 years, is necessary to ensure realism between the long term plans and the expected budgets in order to avoid imbalance between defence ambitions and defence means. Insight into the defence output is necessary to ensure that a given structure is cost-effective in relation to the defence mission. Furthermore to evaluate whether it is sufficient to fulfil the defence mission or whether a change in budget constraint (or structure content) are required.

Scenarios are an important tool for designing, and measuring, defence outputs. They also represent a useful backdrop to discuss different defence components' relevance to alternative military challenges. For measuring defence output, scenarios describe alternative challenges against which defence

structures' output are tested or measured by war gaming and computer based simulations. More than 17 scenarios have been developed by the MFU03, including both war fighting and non-war fighting scenarios. Special attention has been given to potential conflicts outside Norway where Norwegian forces could be called upon to participate in a typical international Smaller Scale Contingency.

A long-term perspective is necessary because the implications of decisions (or lack thereof) would first become apparent after some years. Such a perspective reduces the constraints from present solutions and heritage in order to rethink how to adapt the defence to a changing world and an improved resource balance.

The recent "Handbook in Long Term Defence Planning" (SAS-025) makes designing a force structure a straightforward process in many ways. Figure 1 illustrates how this process can be decomposed into different activities. The model is presented in "steps" but it is important to have in mind that the actual process is more intricate than this. The process contains feedback (double arrows) and other processes may run in parallel as well as a holistic iterative process.

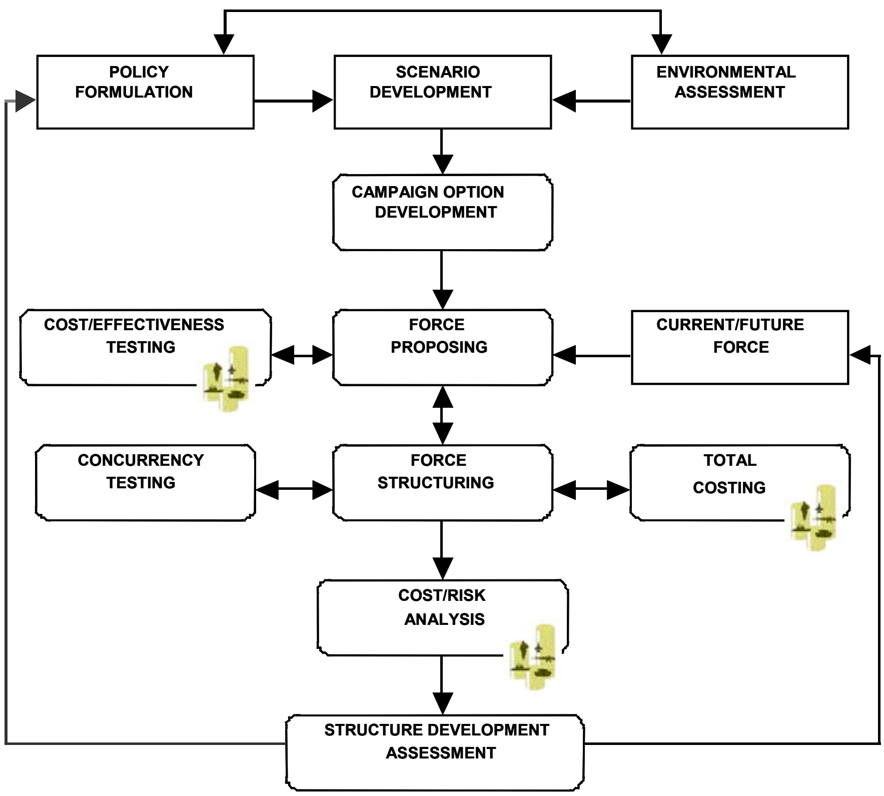

Figure 1 Long-term planning process "best practice model" (SAS025) and the use of KOSTMOD

Figure 1 shows that when scenarios have been built, taking environmental assessments and policy goals into consideration, campaign options are diverted from different threat campaigns. Force packages are then proposed – consistent with mission objectives within each of the 17 scenarios.

These force components are then tested against the campaign options to ensure their viability and suitability. The aim is to refine the force components, for a particular scenario, so that there is confidence that they will meet the minimum requirements consistent with the level of risk outlined by the policy formulation. The output is a set of ideal force components for each of the different scenarios. These are then built up in an overall force structure taking account of i.e. training, rotation and maintenance.

The cost estimates seek to present a complete picture of all costs associated with implementing and operating the various defence structures in peacetime. Effort has been made to reflect the true costs of each major force structure component unit and of all the support systems. Costs represented are especially those of operations and investments.

The difference between the final force structure and the current planned equipment and manpower programs give rise to the force structure development plan (SDP) that aligns the long term force goal with the current structure and future programs.

The initial SDP typically exceeds budgetary expectations and further refinement would be required to balance the SDP plan with expected resources. KOSTMOD is an excellent tool for illustrating an SDP and e.g. operations and procurement costs in different force structures. The model is also very suitable for analysis of cost/effectiveness and cost/risk, but as a part of an analysis process together with other qualitative and quantitative models.

3. The Cost simulation model KOSTMOD

KOSTMOD is a database program, developed at FFI over a 20-year period, that simulates investment and operating costs over a specific time period. From such outputs, large discrepancies between budget constraints and resource demand as expressed by defence plans are easily identified. The database program comprises of defence *resources*, *units* and *SDP*. All costs are initially linked to the resources and subsequently units and SDP.

Each *unit* is built up by specifying its need for resources (personnel, equipment and buildings and establishments). A *SDP* defines which units are to be costed at different times. The *SDP* specify when old or new units are phased in and out of the structure. The cost simulation would then for each year compare the availability of resources to the need for resources as defined by the units present in the *SDP*. With insufficient resources in the reserve, the model would automatically invest in more resources and hence generate investments at a given year. Operating costs are generated from

resources present in the structure, and resources not present in the structure but still considered to be operational (in the reserve).

Resources

Resources are personnel (e.g. military officers, civilians, conscripts), equipment (e.g. main battle tanks), and buildings and establishments (B&E). Each *resource* is described by name, age distribution, number, lifetime, yearly loss rates, procurement and operating costs. The future procurement cost is based on a current estimate and a percentage-per-year increase factor. This percentage factor is fixed individually for each *resource* and reflects price increase beyond inflation due to technological development and improvements. A similar approach has been implemented for the increase in operating costs. In the case of operating cost the yearly increase reflects a real increase in e.g. salaries and additional grant in increased risk of mission.

Resource - personnel

There are two main categories of personnel in the database model: military and civilians. Military personnel require an initial training cost in terms of both money and training time while civilians can be hired over the labor market at zero initial costs. There are four types of military personnel, officers of high rank (permanent employed), officers of low rank (temporary employment), privates on long term (3-7 years) and conscripts. The privates serve for about one year (conscripts) whereas officers either work temporarily (low rank) in the defence or attend the war academy and become an officer of high rank (permanently employed or after a certain period wishes to leave for a career outside the defence). Required (service dependent) personnel input data is:

Military personnel

- Age distribution
- Percentage expected to quit each year
- Retirement age
- Average wages paid (4 levels)
- Initial training cost

Civilians

- Average wages paid (4 levels)

The need for personnel in each unit determines the personnel operating cost (and initial training) for each defined defence structure estimated in the model.

Resource - Equipment

Altogether there are approximately 400 equipment categories in the cost database. Each service unit is defined by a small subset of these categories, typically from 5-15. Generic types of equipment might for instance be various types of communications, air defence, frigates and machineguns. Each equipment category has assigned the following attributes:

- Historic date of purchase
- Life span
- Loss rate
- Investment cost
- 4 levels of operating costs

The historic data of purchase (age distribution), life span and loss rate enables the model to estimate the need for reinvestments. Figure 2 illustrates a fictional example of the reinvestment function in KOSTMOD (Main Battle Tank)[1].

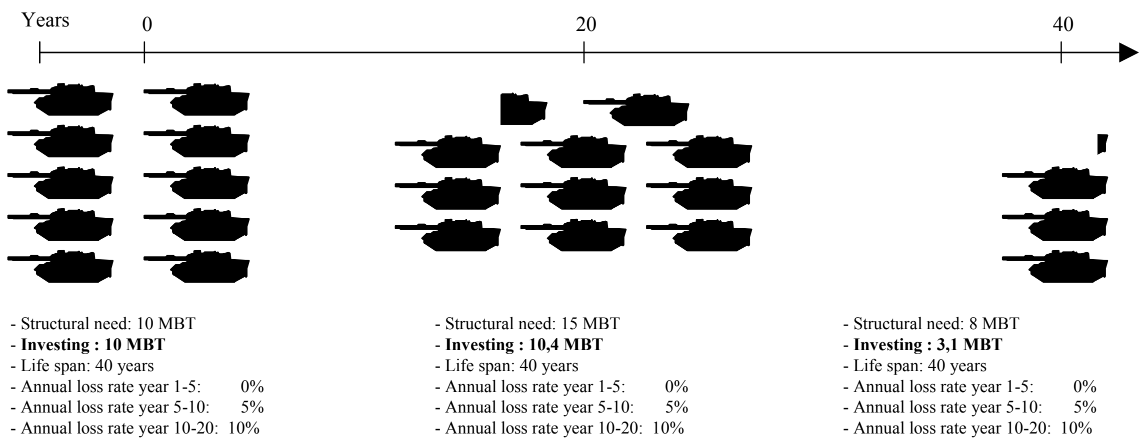

Figure 2 Example of reinvestment function in KOSTMOD

Equipment categories are defined with investment and operating costs. All equipment related costs are assigned to the units that require the respective equipment categories. The investment costs of each component is distributed among the receiving units, so that each unit receives a proportion of the total investment cost that equals the equipment proportion of the total stock. The operating costs depends of the unit's operating level. In KOSTMOD it is possible to divide operation costs into 4 levels. If a unit is a part of an SSC abroad this is considered to be the highest operating level. Units in the reserve forces are considered being the lowest operating level.

[1] When the need of MBT is lower than the stock (loss rate) KOSTMOD will reinvest immediately.

Technically, personnel and equipment are treated the same in the model, thus the dynamics of equipment investments is similar to the initial training of personnel.

Resource - buildings and establishments

The units also require buildings and establishments (B&E). Information on B&E is:

- Investment needs at each unit
- Operating and maintenance costs related to each unit

Whereas the personnel and equipment elements flow freely between the service units, this does not apply to B&E. B&E are not transferable, thus investment costs and operating costs are considered separately for each unit. This approach is more valid for the defence structure in a national context than an SSC in a international context. In a typical SSC mission the B&E will either be hired in the area of operations or one will use different mobile containers. If that is case the B&E resource will be treated as a regular materiel unit in the model and flows freely between the service units.

Resource - growth rates

Experience show that all costs do not necessarily follow the same trend. In the defence structural planning, major assumptions are made about the future cost development. This is implemented in the model through the use of cost growth rates. The growth rates are applied both to operating costs and to investment costs. Figure 3 shows simulations of the initial Norwegian defence structure undertaken with and without the cost growth rates.

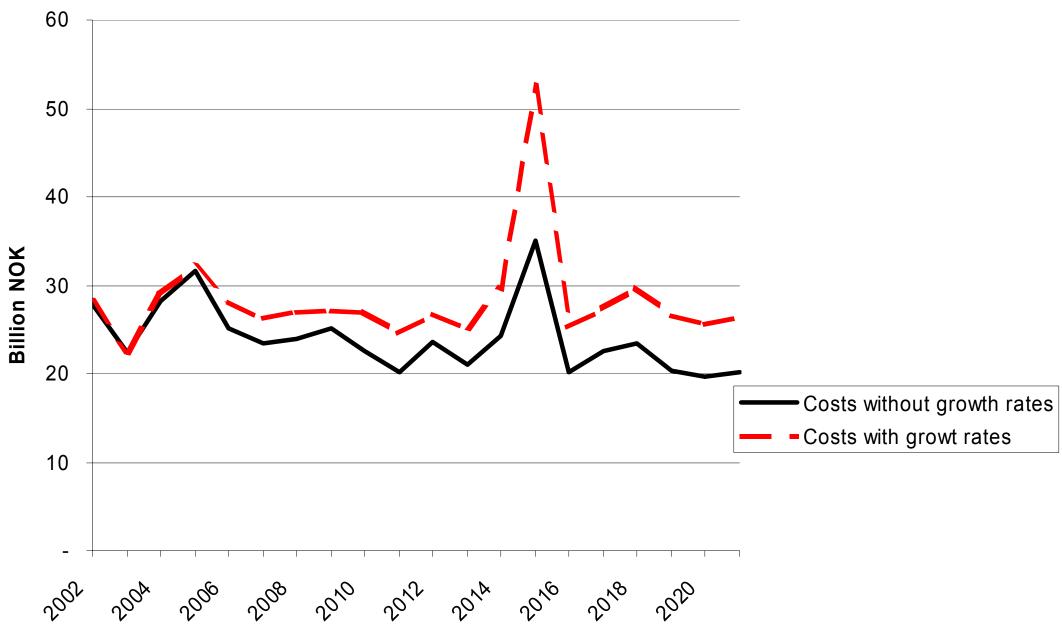

Figure 3 *Cost simulation of the initial Norwegian defense structure, with and without cost growth rates*

The investment cost growth rate reflects expectation of more technically sophisticated solutions over the years. From experience we know that different equipment have different price curves, some points significantly upwards. Based on experience and assumptions it is possible to estimate an investment cost growth rate. The definition of this growth rate in KOSTMOD is the expected growth of investment cost net of growth in the consumption price index.

The operation cost growth rate is assigned to operating costs. The rate is meant to correct for a potential positive or negative real cost growth of operations. Different growth rates might be assigned to the various operating costs. The operating cost growth rate is defined as the expected growth of operating cost net of growth in the consumption price index.

Figure 3 indicates a difference of 86 billion NOK over a 20-year period, whereas the operation cost growth rate represents 50 billion NOK alone.

Service Units

The unit level is chosen so that its effectiveness and cost can be estimated. Each service unit is built up by specifying its need for resources (personnel, equipment and B&E). A unit might consist of one or several major force components. If there is a hierarchy of service units in the force structure one can build different subunits in the model. Each of the subunits can have a unique level of operating costs and a different portfolio of resources. Most units are combat service units maintained at some level of readiness in peace, but it could also be a support, supply or a reserve force unit. One force structure might have few, but a higher percentage of operative major force components units. Another force structure might be dominated by a relatively great number of units in the reserves.

Structure Development Plan (SDP)

A *SDP* defines which units are to be costed at different times. The *SDP* specify when old or new units are phased in and out of the structure. The cost simulation would then for each year compare the availability of resources to the need for resources as defined by the units present in the *SDP*. With insufficient resources in the reserve, the model would automatically invest in more resources and hence generate investments at a given year. Operating costs are generated from resources present in the structure, and resources not present in the structure but still considered to be operational (in the reserve).

4. Experiences with KOSTMOD

There are advantages and shortcomings experienced with the use of cost simulation in long term planning for the Norwegian defence. The major advantage of this type of simulation model is that it

forces the planners and the decision makers to see the defence as a whole, and not as a set of independent weapon systems or units. Making long term plans in a complex organization like the defense it is near impossible to take all relevant factors into consideration without computerized aid. This model points out not only the equipment investments that are to be made each year, but also the related cost of operations. When costs of operations are linked to equipment and personnel no investment can be made at a service unit without affecting the operating costs. This ensures that all costs of an investment are reflected, and it will show the consequences of overly ambitious investment plans to the decision makers.

The units have varying operating costs depending on the activity level and area of operations. One year (or parts of the year) the unit can be on a SSC abroad and another year (parts of the year) the unit can be on national territory practicing for a mission. In other words, the model has options for specifying different activity level for units that other wise are identical, with respect to equipment and wartime personnel. This implementation method enables the user to make different plans and to have different ambitions with the same set of units and equipment. Operating costs varies with the activity levels of the structural plans, as does the effectiveness.

One of the greatest challenges with the model is the process of collecting input data. It is extremely time-consuming even though a number of systems exists that contain records on the various stocks and activities. There is no other system today that relates costs directly to the service units that employ personnel and equipment. FFI has cooperated with the Service staffs and the Material commands in order to collect data from various parts of the organization. The data has then been systemized and aggregated to an acceptable level of modeling.

Another great challenge is advising the organization with the two alternatives of implementing radical operating costs cuts or to hardly invest in new equipment at all. These decisions have historically been postponed which implies an implicit decision to favor operating costs over investments. The recent defence study in Norway, the Defense Study 2000, took this challenge seriously and implied large cuts, and pinpointed a smaller cost-effective peace time organization, simultaneously as the war units leaped technically and focused more on missions abroad, and nationally, in a typical frame of SSC. In this work the cost estimation made by KOSTMOD proved its place in the Norwegian long term planning process.

Bibliography

RTO-TR-69 *Handbook in Long Term Defence Planning,* Research and Technology Organization (NATO), April 2002

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Winchester, October 9 2002

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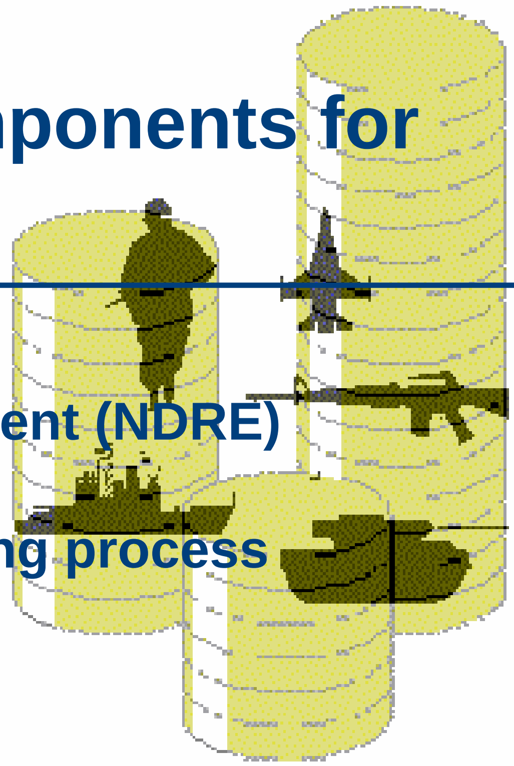

- Norwegian Defense Research Establishment (NDRE)
- Overarching method in Long-term planning process
  - focus on SSC
- KOSTMOD – Strength of approach
- KOSTMOD – main principles in the model
  - Equipment
  - Service Units
  - Structural plans
- KOSTMOD – Challenges

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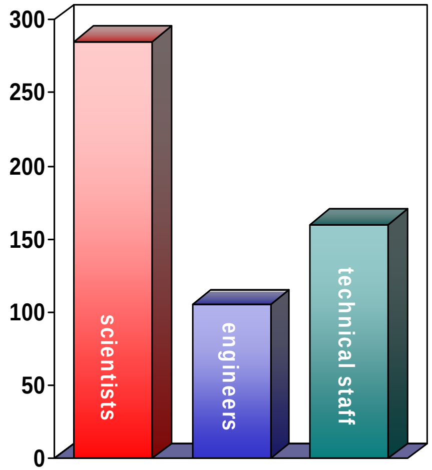
NDRE
Main characteristics




Located at Kjeller, Norway


Scientific Marine Vessel

- **Project organization**
- **Organized under the MOD**
- **Long and short term orientation**
- **Close relations and co-operation with the Defence HQ and procurement agencies**
- **Joint planning of R&D between FFI and the Defence HQ**
- **Co-operation between the Defence HQ, FFI and industry in concept, development and production phases**
- **The leadership of FFI has scientific background**

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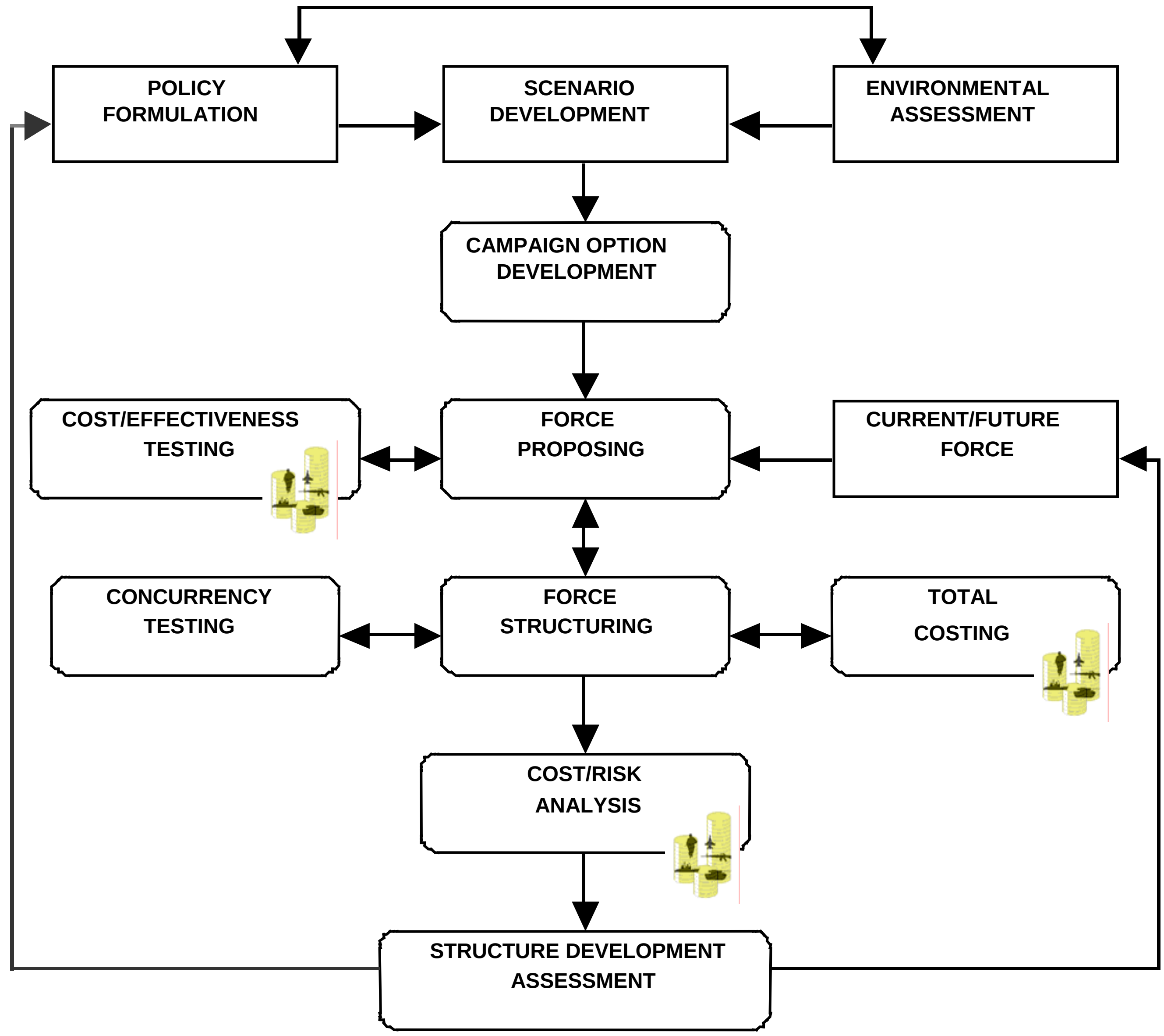
SAS-025
Long-term
planning
"Best practice
model"



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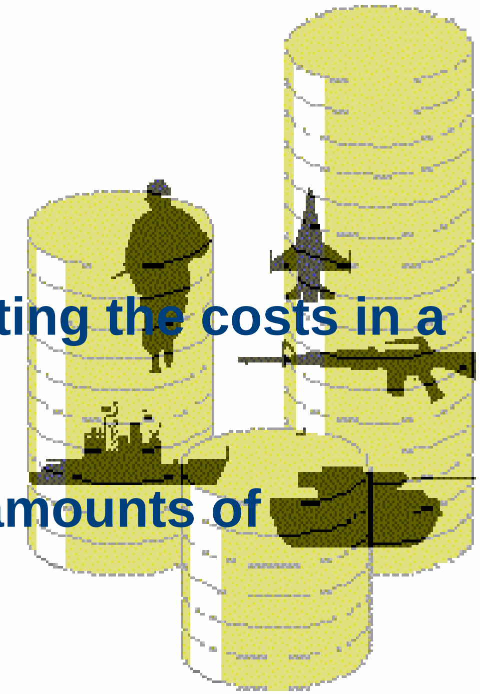
KOSTMOD (3.0)



A relatively easy and holistic model for estimating the costs in a branch, SSC and/or Defence system

No magic functions, but keep's track of large amounts of information in different combinations

- **Puts basic data in system**
- **Relatively good reporting opportunities**
- **Long term planning (*not* annual budgeting)**

PC-oriented and user-friendly with MS support (excel etc)

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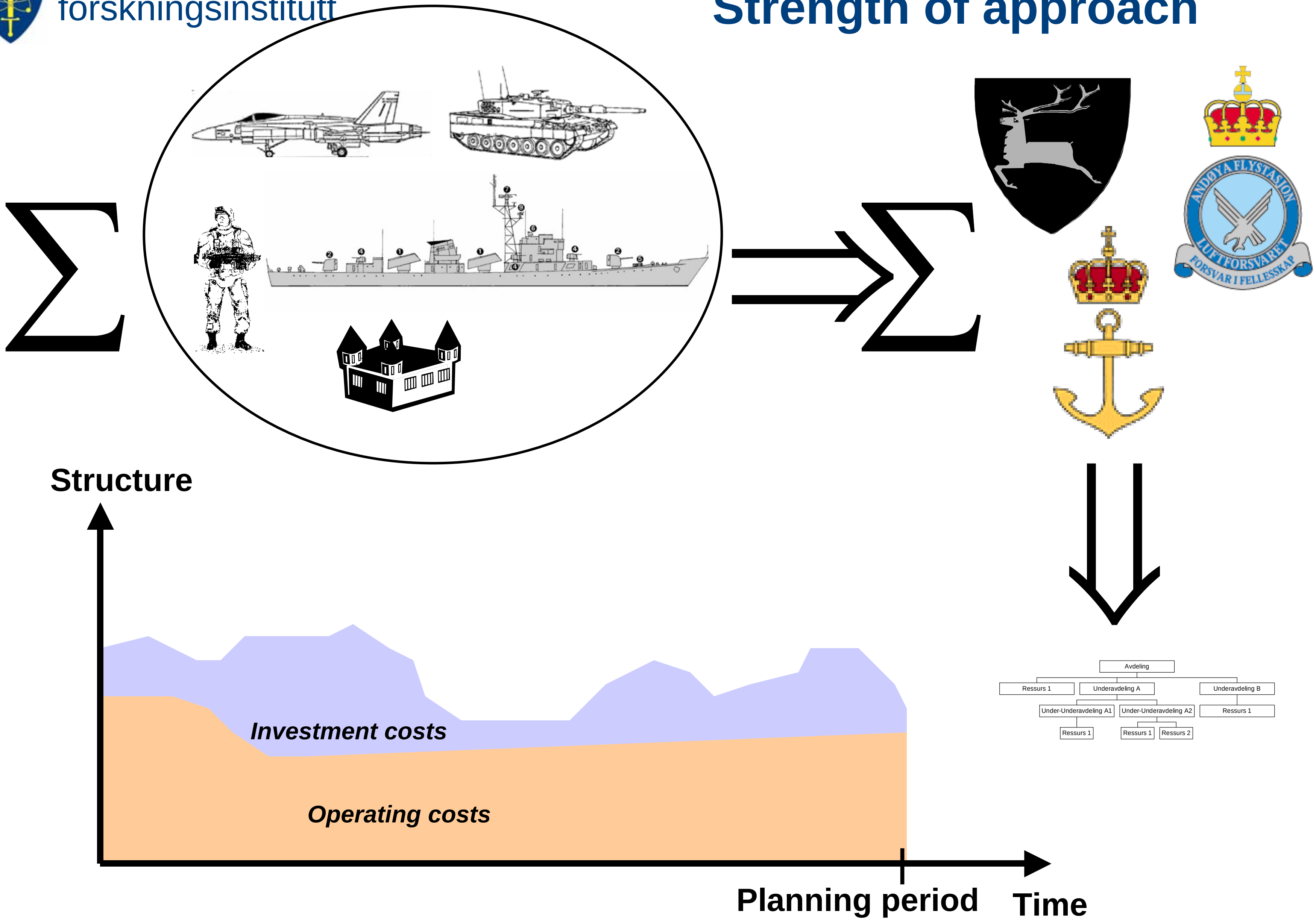
Strength of approach



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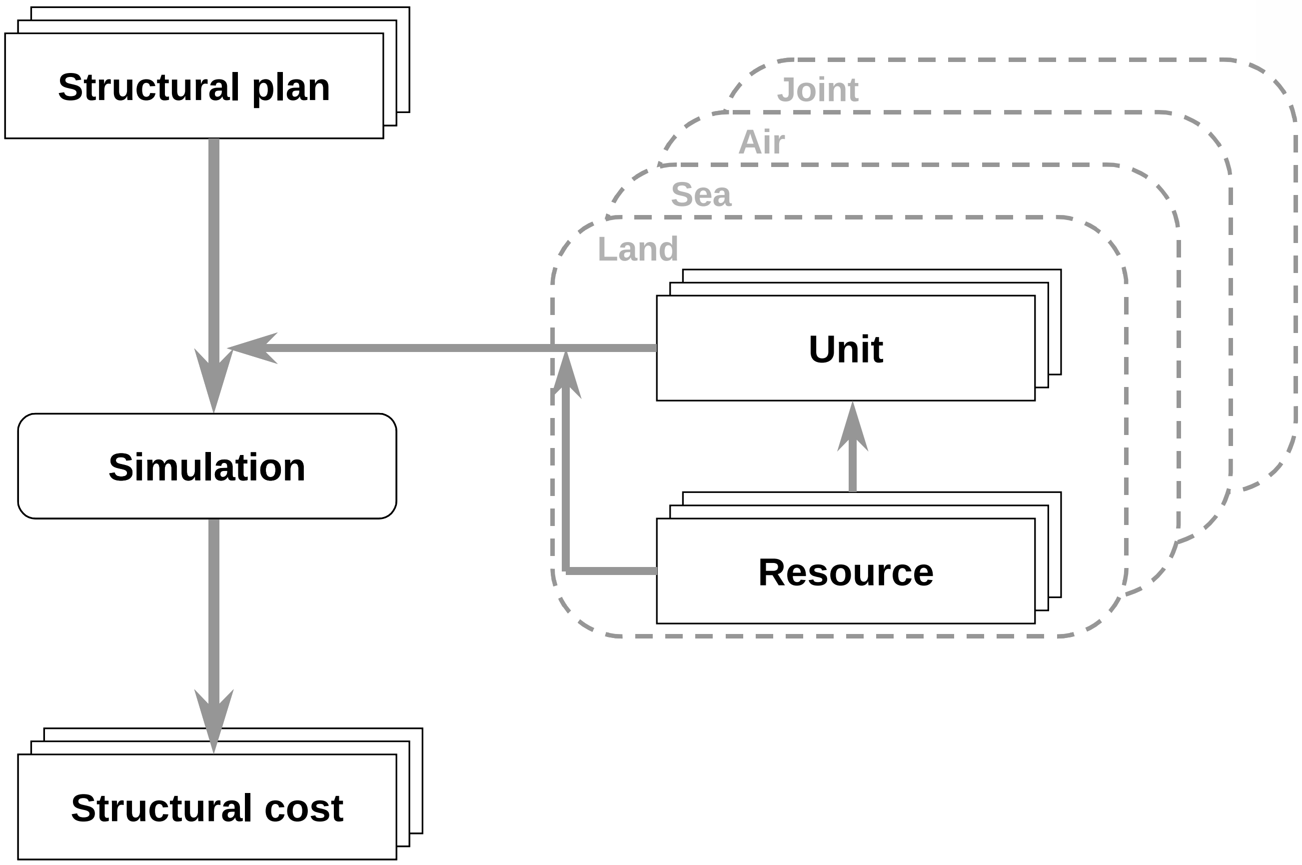
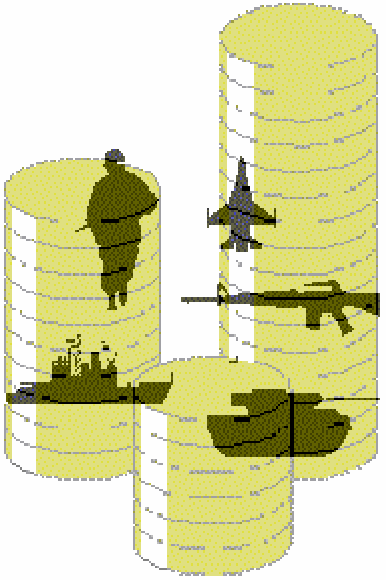
KOSTMOD – the model





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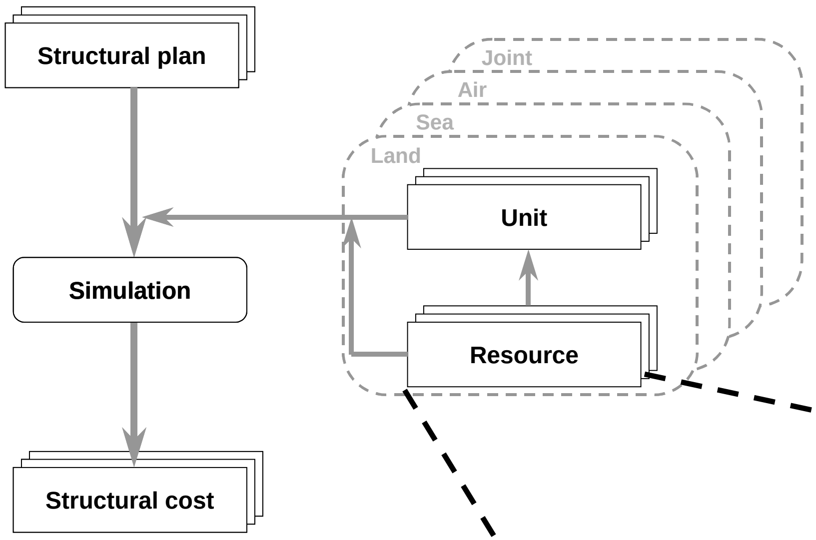
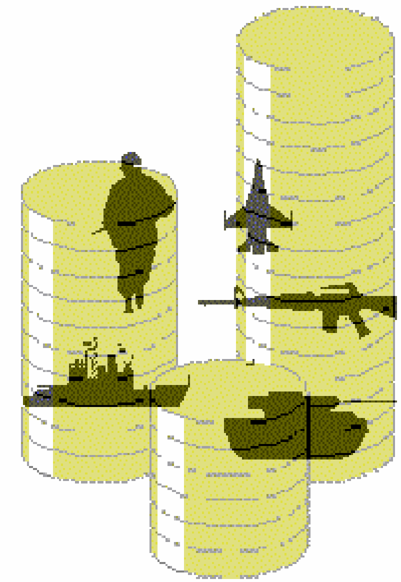
Equipment in KOSTMOD





- Investment cost
- Investment cost escalation factor (ICE)
- Age distribution of stock
- Life expectancy
- Loss rate
- Operating cost (4 levels depending on pattern of use)
- Operating cost escalation factor (OCE)

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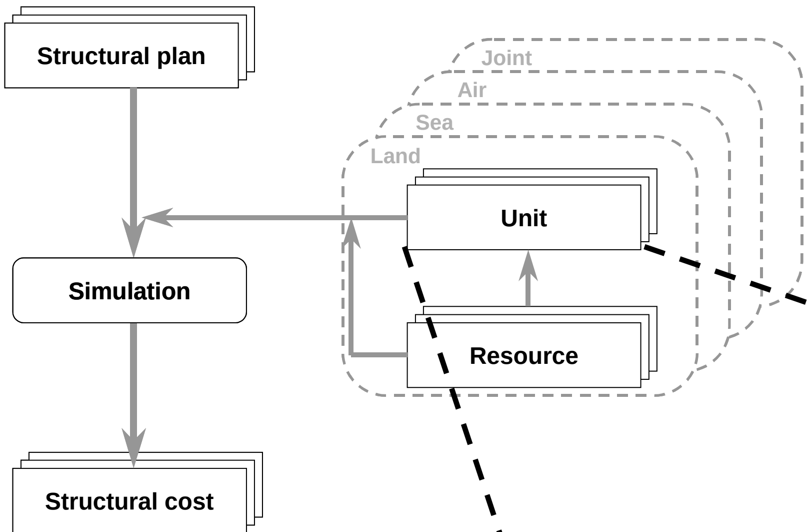
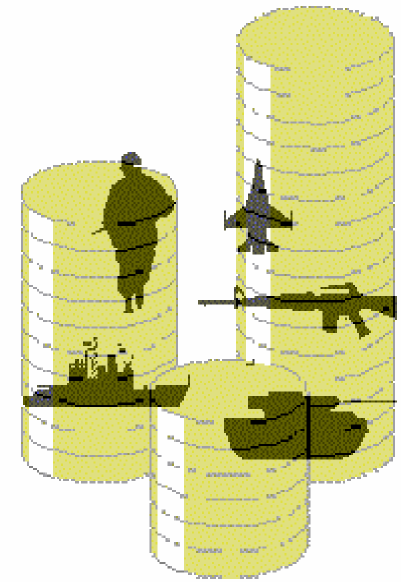
Units in KOSTMOD





- **Unit requirements**
  - Equipment
  - Personnel
  - Barracks and establishments

- **Sub units**

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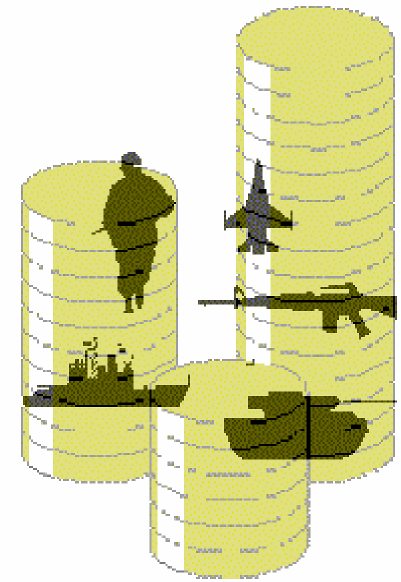
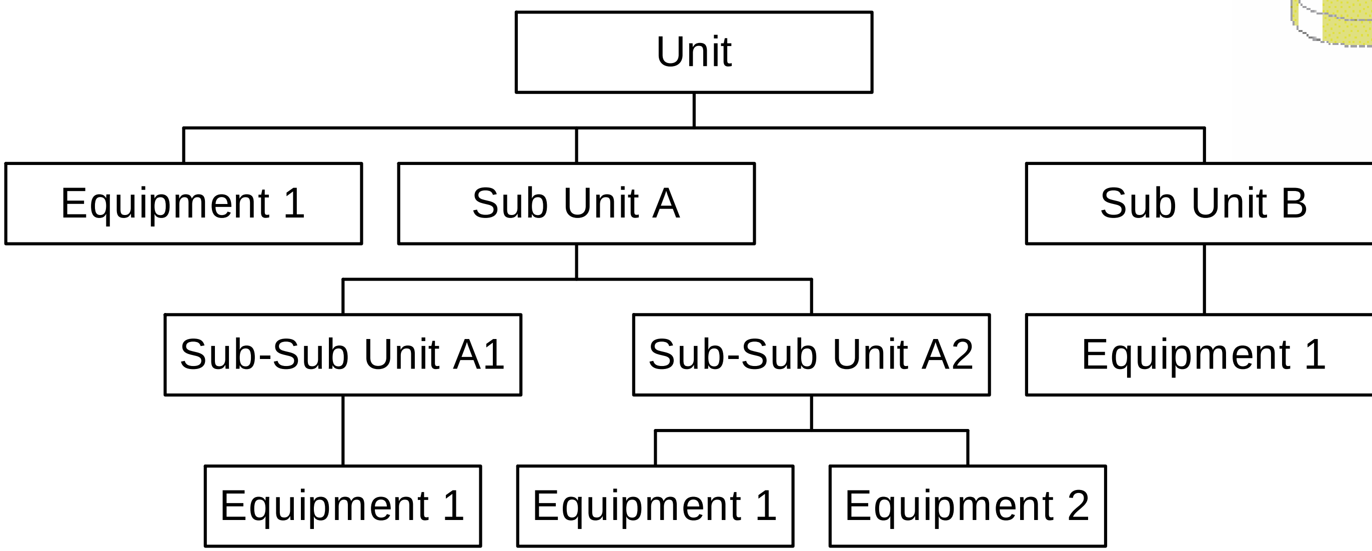
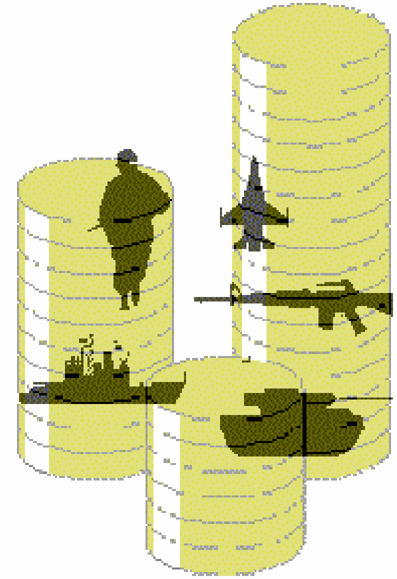
Unit hierarchy in KOSTMOD



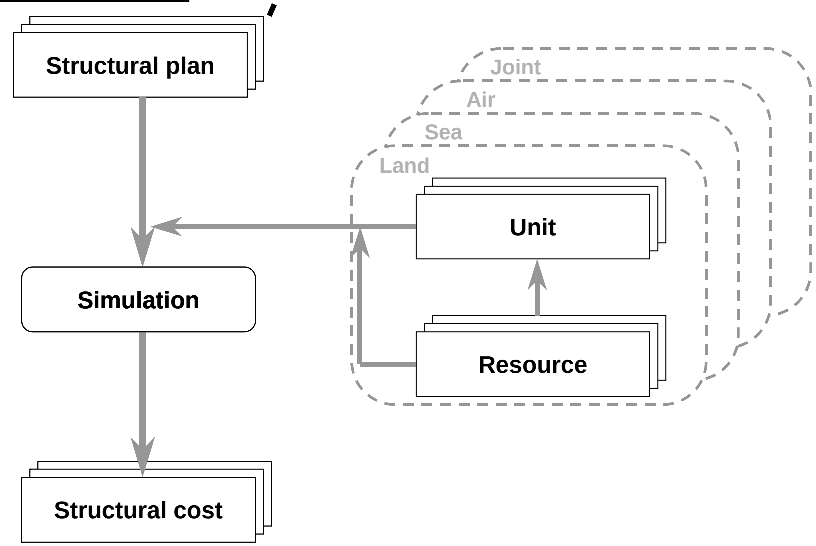


- different equipment
- different pattern of use per unit and sub unit

Structural plans in KOSTMOD



- **Status**
  - **- existing units**
- **Implementation**
  - **- Period of restructuring**
  - **- New units/capacities**
  - **- MLU etc**



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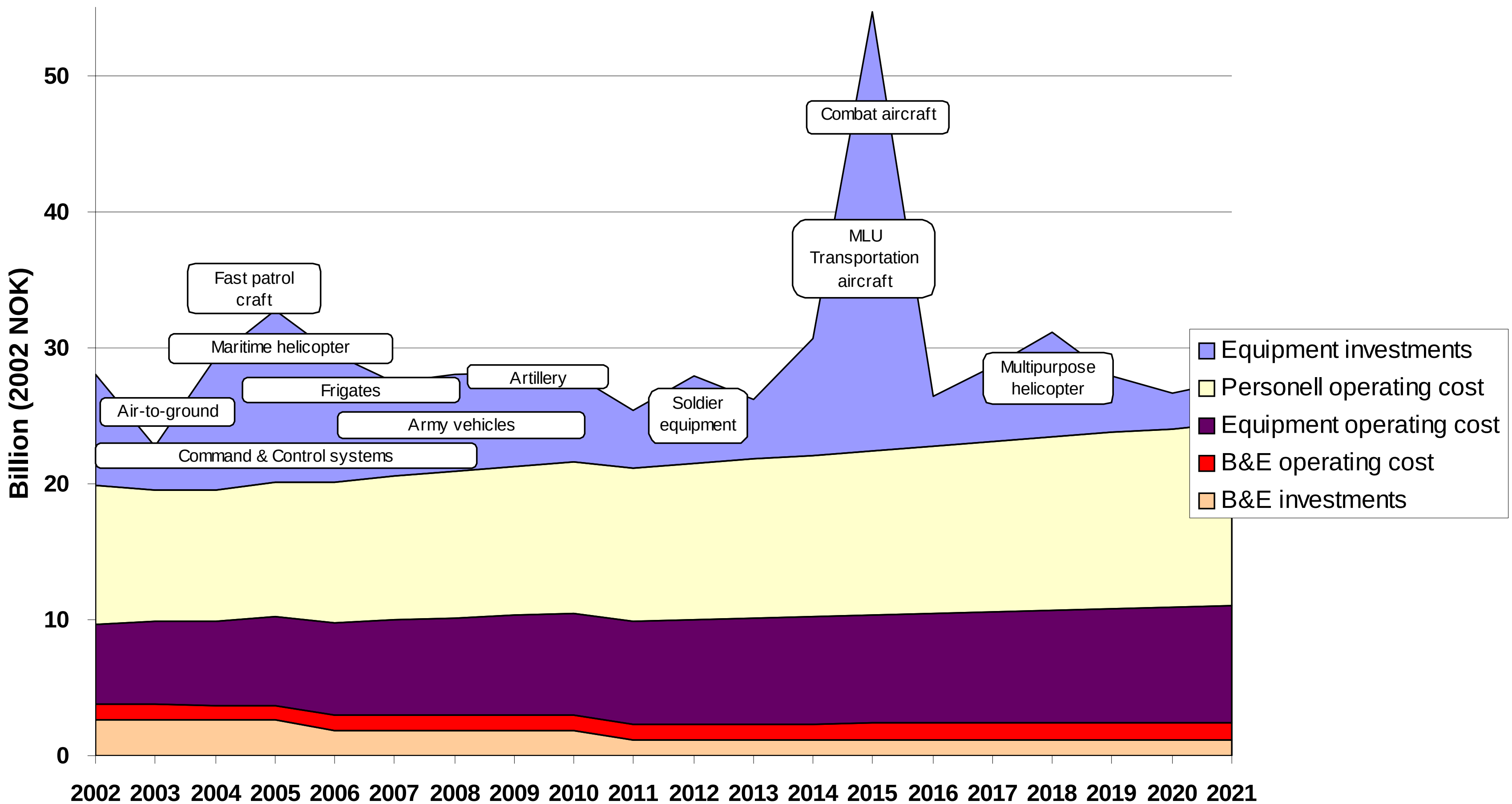
Example of output



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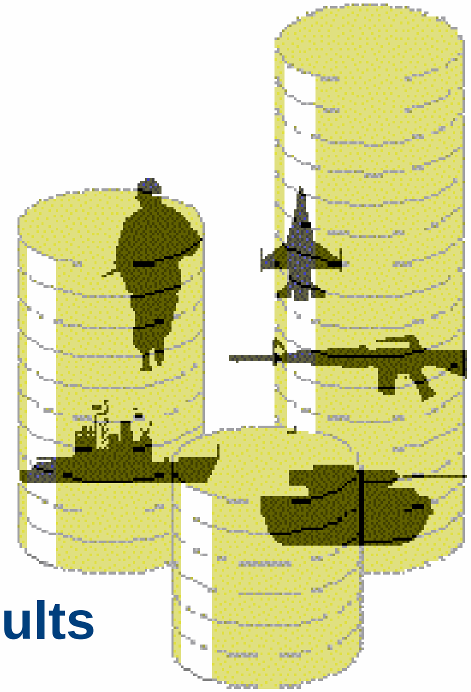
Challenges



- Making realistic assumptions
- Keeping the database updated
- High initial threshold – potential misuse of results
- Engagement in Service staffs
- Mutual acceptance of input (and output)

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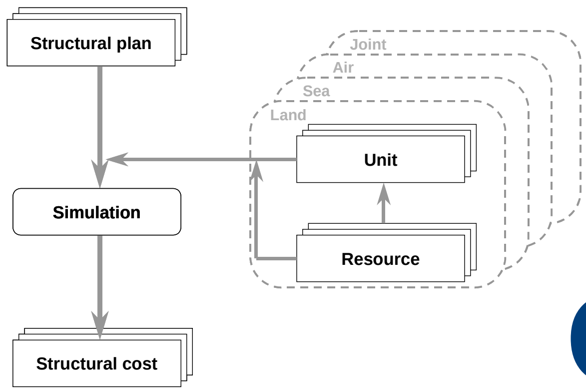

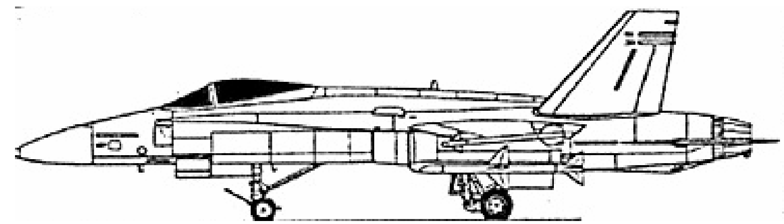

Questions

-

Discussion